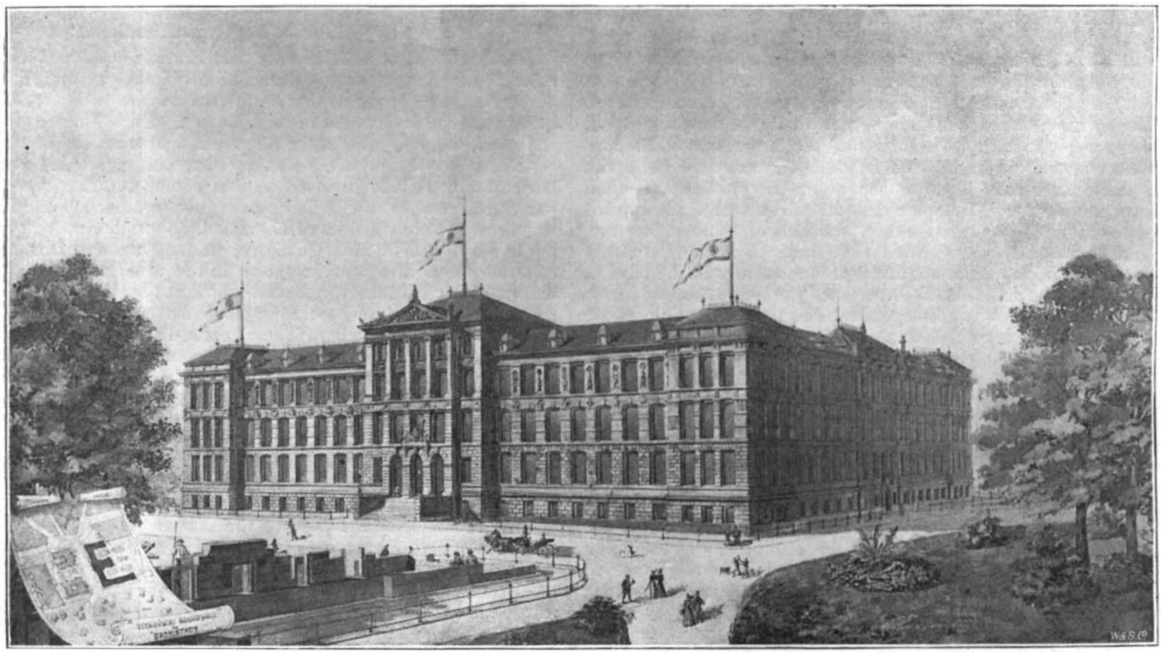
THE NEWEST GERMAN POLYTECHNIC.

WHETHER there is any sufficient ground for the opinion that Germany, by reason of her superior educational system, is gaining at our expense an undue share of trade and commerce, is a question on which statistics of exports and imports necessarily throw much light, although they fail to completely satisfy those who have watched the recent rapid development of German enterprise. Be that as it may, there can be no doubt as to the efforts which Germany is making to improve her trade by taking advantage of every application of science that may seem likely to help in developing her industrial operations. We are sometimes apt to think that, whilst we are gradually improving our educational machinery at home, Germany is standing still. But this is not so. On the contrary, experience seems to have strengthened her belief in the value of the higher scientific education, and there is no unwillingness on the part of the several German States to incur the expenditure needed to render its benefits readily accessible. The new Polytechnic at Darmstadt is a case in point.

For many years Darmstadt has had in the *Kapellplatz* a technical high school, which had gradually grown in size till it occupied eight separate buildings. Latterly, however, it became too small for the increasing number of its students, and the question of its further extension was carefully considered. The immediate cause, however, of the erection of a new building, was the recent rapid development of the electro-technic school, which, commenced on a very small scale in 1882, has now become the most important section of the new institute. It is interesting to note that we in England were the first to establish a school for the study of the technical applications of electrical science. For a short time the Finsbury College had no rival, and in 1882 the appliances in German schools for practical instruction in electrical engineering were meagre in the extreme. The state of things now is very different, and the institution at Darmstadt is a good example of recent progress.

The necessity for extending the old technical school was soon recognised by the State authorities, who at once offered to provide £16,000 for the erection of special electro-technic laboratories, and £11,250 for equipment.

Simultaneously with this offer came a suggestion from the city of Darmstadt to take over the old buildings in which the Polytechnic had been housed, and to contribute towards the erection of a completely new school the sum of £60,000, it being understood that with the payment of this amount all duties and obligations of the city towards the school should cease. This generous offer was at once accepted by the State, and a site measuring about 24,000 square yards was provided in the beautiful gardens adjoining the city. The preparation of the plans was entrusted to the official State architect, with whom, however, were wisely associated the two Professors of Architecture, Dr. Wagner and Dr. Marx, who had been connected with the school for over twenty years, and were thoroughly familiar with the requirements of the different faculties, and were able easily to ascertain the wants of their several colleagues.

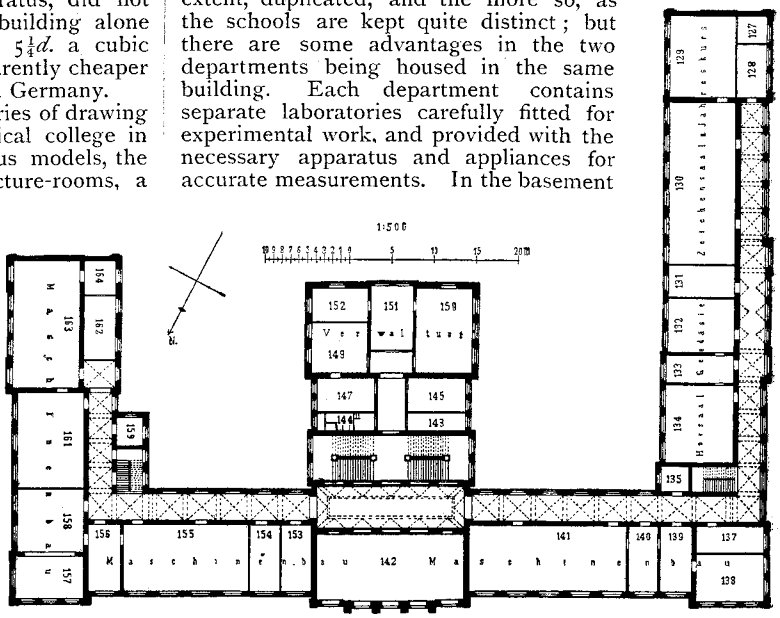


The Darmstadt Polytechnic—Main Building.

The main building, as shown in the sketch, is three-storeyed, and has a north frontage. There are three wings at right angles to it, which are given up to the teaching of mathematics and some branches of natural science, and to the schools of architecture and engineering. In these wings first year's students receive their instruction. Opposite the front entrance of the building, and on the other side of the road, are two separate institutes—one of which contains the physical and electro-technic schools, and the other the chemical laboratories and class-rooms. In the rear of the main building is the engine-house, from which electric light and power and heat are supplied to all three buildings.

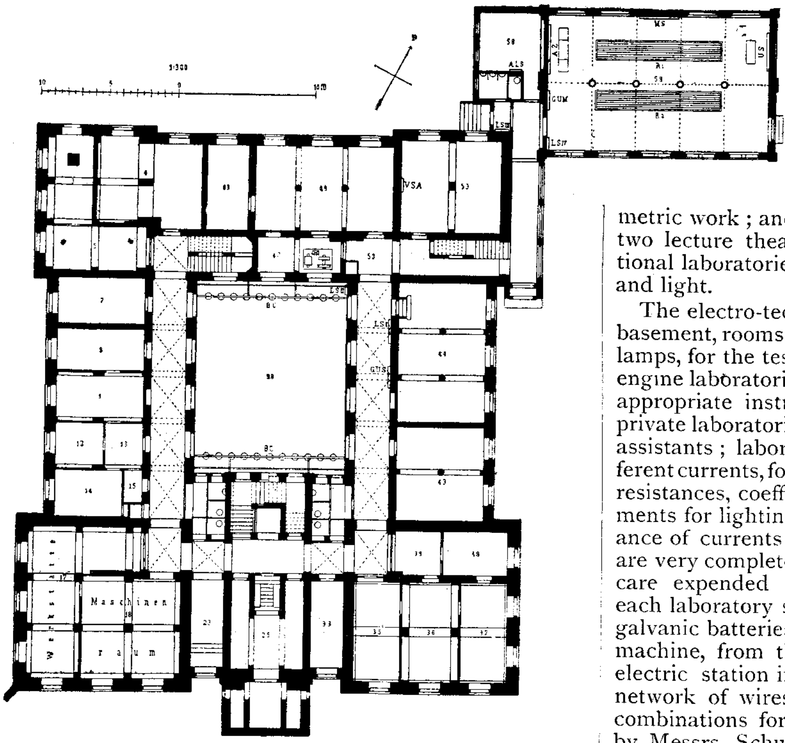
In the fitting and equipment of the several laboratories, class-rooms, and lecture-rooms, all the professors lent their aid, each advising with respect to his own particular department; and to the expert assistance thus obtained is undoubtedly due the completeness and the economy effected in the details of all the arrangements for practical instruction and experimental work. The building was begun in February 1893, and was completed in October 1895. The cost of the entire institute, including fittings, furniture, machinery and apparatus, did not exceed £120,000. The cost of the main building alone was £46,485, which works out to about 5¼*d.* a cubic foot; and this gives some idea of the apparently cheaper rate at which such buildings are erected in Germany.

The main building contains the usual series of drawing offices—a special feature of every technical college in Germany—rooms for collections of various models, the engineering laboratories, class-rooms, lecture-rooms, a large hall, a library, and the administration offices. The arrangement of rooms on the first floor, mainly devoted to mechanical engineering, is shown on the annexed plan.



Main Building—First Floor Plan.

The most interesting department of the institute is undoubtedly the building devoted to the physical and electro-technic schools. This is divided into two distinct sections—the one for instruction in physics proper, including electricity, and the other for the technical applications of electricity. In the annexed plan of the ground floor, the rooms on the left of the central court belong to the physical, those on the right, including the annex containing the dynamo and motor machinery, belong to the technical section. Each section contains workshops for the making and the repairing of apparatus, but these shops are not used by the students. Indeed, workshop training does not, even now, form any part of the curriculum of students at a technical high school. They are required however, during their course of study, to spend parts of their long vacations in engineering shops; and no difficulty is found in obtaining for students admission to the State railway works, or to the machine shops of well-known electrical firms.



Ground Floor Plan of adjoining Physical and Electro-technic Institute.

The apparatus of the two divisions of the physical and technical institute is necessarily, to some extent, duplicated, and the more so, as the schools are kept quite distinct; but there are some advantages in the two departments being housed in the same building. Each department contains separate laboratories carefully fitted for experimental work, and provided with the necessary apparatus and appliances for accurate measurements. In the basement of the physical department is a room specially fitted with double walls for experiments requiring uniform temperature, rooms for chemical and photographic work, an engine-room containing a gas motor, dynamos, and other machines. On the ground floor are separate laboratories for the Professor of Physics, Dr. Schering, and for the chief assistant, a laboratory for magnetic experiments free from iron fittings, and other separate laboratories for galvanic, optical, and photometric work; and above this floor are the balance rooms, two lecture theatres and preparation rooms, and additional laboratories for exercises and experiments in heat and light.

The electro-technic section of this building has, on the basement, rooms for accumulators, for testing arc and glow lamps, for the testing of cables, besides the dynamo and engine laboratories. These are all carefully equipped with appropriate instruments and apparatus. Above are the private laboratories of the Professor, Dr. Kittler, and of his assistants; laboratories for measuring the strength of different currents, for magnetic investigations, for determining resistances, coefficients of induction, &c. The arrangements for lighting the lecture-rooms, and for the conveyance of currents from different combinations of batteries are very complete, and give evidence of the thought and care expended on the equipment of the school. To each laboratory separate currents are supplied from the galvanic batteries and dynamos, from the main current machine, from the accumulators, and from the central electric station in the rear of the main building. The network of wires, which can be connected in different combinations for experimental purposes, has been fitted by Messrs. Schuckert, of Nürnberg, in whose works are found a large number of the students who have received their training at this school.

There are already over three hundred students in this one department of the Darmstadt High School, and the building, which was completed in October 1895, is now being extended. The course of instruction covers four years: the first year is spent in the main building, in a general course of scientific study; the second is given up to physics, and the last two years are devoted to practical exercises in the electro-technic institute.

The chemical school is housed in another separate building, which also consists of two departments—the one for the study of pure chemistry, and the other for the study of chemical technology, electro-chemistry and pharmacy. The department for pure chemistry consists of three large laboratories for analysis and preparation work, and of a number of smaller laboratories for special researches. It has accommodation for sixty to seventy students. There are separate rooms for thermo-chemical, spectroscopic, photometric, and other physical experiments, as well as rooms for chemical investigations connected with secondary and other batteries.

The other side of the chemical school is mainly devoted to the study of electro-chemistry, and is equipped with the necessary apparatus and machinery, including continuous and alternating current dynamos, for experiments and researches in this special branch of applied chemistry.

The foregoing sketch gives only an outline of the facilities for the higher scientific education which are provided in the Darmstadt Institute, the most recently equipped of the many German technical high schools. The attendance of students during the recent summer semester is given as follows:—

Departments.	Regular students.	Occasional students.	Total.
Architecture	74	13	87
Engineering and machine construction ...	351	37	388
Electro-technology ...	307	23	330
Chemistry	89	13	102
General science	29	18	47
	850	104	954

In the chemical department, 39 are returned as students in the electro-chemical section.

The teaching staff for these 954 students might seem to us excessive. It consists of 27 ordinary and of 6 extraordinary professors, of 22 demonstrators or instructors, and of 22 assistants, making a total of 77. The students' fees vary from £8 to £12 a year, and the whole of the deficit on the cost of maintenance is defrayed by the State.

PHILIP MAGNUS.

A VISIT TO AN ENGLISH WOAD MILL.

A REFERENCE to any old gazetteer under the name Wisbech will show that this town was once an important centre of the English woad industry. It is not generally known, however, that woad is still grown and worked up in a few localities, and it was with some surprise that we learnt that the processes connected with the manufacture might be seen in operation at Parson Drove, near Wisbech, at the present time. There are said to be three other places where the plant is cultivated and worked up for use by dyers—one near Boston and two near Holbeach, in Lincolnshire; but at these centres the introduction of steam power has destroyed the primitive character of the manufacture. As an interesting survival of the past, the mill at Parson Drove is well worthy of a visit.

It is hardly to be expected that a feeble tinctorial substance, such as woad, can retain a permanent footing as an English product in view of the circumstance that it has to compete with indigo, as well as with its modern coal-tar substitutes. The thought that this old-time industry, like the potash-making in Essex,[1] is sooner or later destined to become extinct, has led us to place upon record the information which we gathered during a visit to the Parson Drove mill in July of this year. We may add that descriptions of this mill were given in the *Gardeners' Chronicle* in 1881[2] and 1882; but, as we obtained later and more detailed statements on the spot, concerning the actual operations as now conducted, it may be of interest to chronicle the facts once again while it is still possible to get particulars from the woadmen at first hand.

The leaves of the plant (*Isatis tinctoria*) are wrenched off at the base by the pickers, the root being left undisturbed, so as to permit the growth of a second crop. The first process consists in crushing the leaves to a pulp under rollers. The latter, of which there are three at the Parson Drove mill, are hollow, slightly conical, wooden drums, with about two dozen iron cross-bars arranged round the circumference, these iron bars furnishing the effective crushing edges. The three rollers are geared to a long projecting horizontal pole, which is made to move round by means of a horse. The pulpy mass resulting from the crushing operation is then kneaded by hand into balls, about the size of cricket-balls, on a wooden stage, the balls, when made, being placed in three rows on wooden trays, which, as they are packed, are pushed up a sloping plank till high enough to go on to the head of a man who stands at the end to receive them. Each tray, as it is delivered, is carried to the drying sheds. The balls are allowed to dry in the air for about four weeks, and are for this purpose transferred from the trays to wooden gratings arranged in tiers in the roofed, open framework sheds, known locally as "ranges" (shown in the illustration). When dry, the balls are again ground up under the rollers, and the material then conveyed to the floor of another roofed shed, where it is sprinkled with water, and allowed to ferment for a period of nine weeks. The shed in which this process goes on is known as the "couching-house." The fermenting mass is constantly turned over by the workmen, and water added from time to time. We were told that the fermentation is at first very vigorous, the mass getting quite hot and steaming. At the end of the process in the couching-house the woad is ready for the market, and is simply packed tightly into wooden casks for sending away.

The primitive character of the manufacture makes it not only of interest as a lingering survival of an ancient rural industry, but the antiquarian and lover of folk-lore may derive instruction from the mode of construction of the rough sheds, and from the technicalities used by the workmen. Thus the term "couching" is used in a similar sense by maltsters, and is no doubt a Norman survival (Fr. *Coucher*); the sloping plank is called the "firm" (? form), and the tray on which the pulp is kneaded is known as the "balling-horse." The balls were formerly dried on wattles, known as "fleaks," a term apparently identical with the word still used for hurdles in Scotland; but these are no longer used at Parson Drove. The central circular shed containing the rollers is built of wooden planks and posts, and thatched with a conical roof; the lateral couching-house is constructed of thick turf walls, with the slabs arranged in a peculiar herring-bone form, and also roofed with thatch.

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[1] See a paper by Henry Laver in the *Essex Naturalist*, vol. ix. p. 119.

[2] The writer of this article acknowledges, as the source of his information, a recent paper in the *Friends' Quarterly Examiner*. An interesting popular account of the mill appeared in *Aunt Judy's Annual* volume in 1883.